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(54) PREVAILING TORQUE FASTENER

(71) We, STANDARD PRESSED STEEL CO., a Corporation organised and existing under the Laws of the Commonwealth of Pennsylvania, United States of America, of Jenkintown, Pennsylvania 19046, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This application relates to self-locking fasteners and, more particularly, to self-locking fasteners of the prevailing torque type and to joint assemblies in which prevailing torque type fasteners are used.

Self-locking fasteners of the prevailing torque type generally include an externally-threaded shank having a locking portion including axially-deflected or otherwise axially-deformed thread portions. When engaged with a mating threaded portion, the locking portion provides additional force on the mating thread which adds to the torque required to rotate the fastener relative to the mating thread. Thus, additional resistance to loosening of the fastener due to vibration and other accidental torque is provided.

When conventional prevailing torque type fasteners are seated in a mating threaded portion, the locking portion does not deform to any substantial extent, but causes a plastic deformation or, in most applications, a shearing of the flank of the mating thread in the region of its pitch and major diameters.

Thus, the cross-sectional configuration of the mating thread is significantly reduced and otherwise deformed. After the fastener is removed from the mating piece, the mating thread is so deformed that it is generally not re-usable in a satisfactory manner; after several removals of the fastener from the mating piece, the mating thread can be so damaged that it may not be re-usable at all. When the mating piece is a nut, the nut is usually replaced after one or two removals of the fastener which results in added expense in maintaining the joint. When the mating piece is a joint member having a tapped hole forming the mating thread, the hole must be redrilled and tapped and oversized fasteners must be used. Accordingly, maintaining a joint utilising a prevailing torque type fastener and a tapped hole in a workpiece is also relatively expensive. In addition to the expense, the reduction in the cross-section of the thread on the mating threaded portion, i.e., nut or tapped hole, significantly reduces the strength of the joint.

It is an object of this invention, therefore, to provide a prevailing torque type fastener that allows for increased reusability of the mating thread.

It is another object of this invention to provide a prevailing torque type fastener that does not significantly deform the mating thread flanks at the pitch or major diameters.

It is yet another object of this invenfion to provide a joint including a prevailing torque type fastener and a mating thread having improved reusablility.

These and other objects of this invention are accomplished by providing a fastener of the prevailing torque type comprising a shank having a helical thread formed thereon said thread on the shank including a portion having a load-bearing flank and a non-load-bearing flank, referring to the tightened condition, said flanks being joined at their major diameter by a crest and at their minor diameter by a root, said crest and said root each defining a helix around said shank, at least one segment of said tread on the shank being formed as a locking portion wherein said entire root is axially displaced in one direction relative to the helix of the root of the remainder of the thread, the entire crest adjacent said displaced root is axially displaced in the same direction relative to the helix of the crest of the remainder of the thread and is axially thicker than said remainder of the

crest and the surface of said locking portion between said displaced root and said displaced crest is also displaced axially in the sam direction as said displaced root and crest.

In one embodiment of the invention described herein a plurality of the locking portions are formed adjacent each other on the same convolution of the thread, the convolution extending through a segment of 360° around the thread. Alternatively, the locking portions may be on adjacent convolutions of the thread, each convolution extending through a segment of 360° around the thread. The or each locking portion preferably has a circumferential extent of less than 180°. Where the locking portions are on the same convolution of the thread their total circumferential extent is preferably less than 180°.

The invention also includes a joint assembly comprising a plurality of workpieces each having an opening extending therethrough, a fastener as set out in either of the two immediately preceding paragraphs in which the thread on the shank portion thereof is externally-formed on said shank portion, and an internal thread configuration having a mating thread generally complementary to said external thread on the fastener.

For a better understanding of the invention, reference may be made to the following description of the preferred embodiment, taken in conjunction with the figures of the accompanying drawings in which:

Figure 1 is an elevation of a prevailing torque type fastener in accordance with this invention;

Figure 2 is an elevation perpendicular to Figure 1 of a joint with portions thereof in section and including the prevailing torque type fastener illustrated in Figure 1;

Figure 3 is an enlarged section view of the circled portion illustrated in Figure 2; and,

Figure 4 is a schematic drawing of a mating thread illustrating its configuration before and after engagement with the fastener illustrated in Figure 1.

Referring particularly to Figure 1, there is illustrated a prevailing torque type fastener in accordance with this invention in the form of a screw 10 having a head portion 12 and a shank portion 14. Head portion 12 includes a suitable wrenching configuration and in the embodiment illustrated herein is a socket head having an internal recess (not shown) for receiving a wrenching member, but it should be understood that any suitable configuration can be utilized. Further, it should be understood that a head need not be utilized, but that a wrenching configuration could be formed in the end of shank portion 14 to form a set screw. Formed on shank portion 14 is a helical thread 16 including a root 18 and a crest 20 each of which connects a generally load bearing flank 22 and a generally non-load bearing flank 24. By the term load bearing flank is meant that flank of a conventional thread which when the bolt is engaged with a mating thread contacts the mating thread and is subjected to the load exerted by the tightening of the bolt; by the term non-load bearing flank is meant that flank of a conventional thread which is subjected to little or no load when the bolt is engaged in the mating thread. Root 18, of course, connects the flanks at the minor diameter of the thread and crest 20 connects the flanks at the major diameter of the thread. Both root 18 and crest 20 define a helix angle as is usual in the art.

In the preferred embodiment disclosed herein thread 16 is formed with two adjacent locking portions 26 on each of a plurality of adjacent thread convolutions. By the term "thread convolution" is meant any 360 degree segment around the thread. Since each locking portion 26 is generally the same, only one will be described in detail. Each locking portion 26 comprises a displacement of a segment of the helical thread and includes a displaced root portion 18A, that is, a root portion that is axially offset from or deviates from the normal helix angle defined by root 18. Crest portion 20A radially adjacent root portion 18A is also displaced, that is, offset relative to the helix angle defined by the crest 20 and in the same general direction as root portion 18A. Both root portion 18A and crest portion 20A are offset toward the point end of the screw, that is, the free end thereof, but the crest portion is offset a lesser distance than the root portion. The displacement is gradual, starting at either circumferential end of locking portion 26 and increasing to a maximum at the midpoint between the ends. In addition, crest portion 20A is radially displaced relative to crest 20 so that it defines a slightly larger major diameter than the crest 20 and is also axially thicker than the crest.

Flank portion 22A connecting root portion 18A and crest portion 20A is, of course, also displaced or offset relative to load bearing flank 22 and flank portion 24A is also displaced or offset relative to non-load bearing flank 24. As best seen in Figure 3, flank portion 22A is a generally planar surface or may be slightly concave while flank portion 24A is formed with a bulge that includes a first surface 30 extending at an increased angle relative to crest portion 20A so that a larger angle is included between flank portion 22A and surface 30 than is included between flanks 22 and 24. Thus, the axial thickness of the

thread through the locking portion is increased as well as the thickness of crest portion 20A. Extending from offset surface 30 is a second offset surface 32 which in the preferred embodiment disclosed herein, defines a plane perpendicular to the shank axis. Extending inwardly at an angle from surface 32 toward root portion 18A is a third surface 33 which terminates at a small bubble 28 of lapped material which extends slightly from the root portion. Bubble 28 may be so small as to be barely visible and, it is believed, is formed by some of the original root configuration prior to formation of the locking portion as will be more fully explained hereinafter.

Two locking portions 26 are illustrated adjacent each other on each of four thread convolutions. It should be understood, however, that only one such locking portion need be provided on each convolution but that the use of two locking portions is preferred since it distributes the added locking force over a greater area and reduces the pressure on the thread. Further, it should be understood that if locking portions 26 are to be provided on more than one thread convolution, they need not be placed on adjacent threads but they may be located on alternate thread convolutions or on every third, fourth etc., convolution. In the preferred embodiment, it is desirable to leave at least one thread convolution at the point end of the screw with no locking portion to facilitate the starting of the screw in a mating thread. Finally, as will be made clear hereinafter, it is preferable that the circumferential extent of the locking portions on any convolution does not exceed 180 degrees.

Referring now to Figure 2, screw 10 in accordance with this invention is illustrated in a joint comprising a plurality of workpieces 34 and 36 having an opening 38 extending therethrough. Screw 10 is used to secure workpieces 34 and 36 by cooperating with a nut 40. While a nut is illustrated, it should be understood that a nut need not be utilized and that a mating thread could be formed directly in one of the workpieces. Referring to Figures 3 and 4, the nut has a thead 42 including a minor diameter portion 44, a major diameter portion 46, and a pair of flanks 48.

In use, self-locking screw 10 is threadably engaged with nut 40 in a conventional manner. When locking portions 26 engage mating thread 42, the locking portions undergo a slight elastic deformation and also cause deformation of mating thread 42. The deformation of locking portions 26 may be elasto-plastic, i.e., primarily elastic with some small percentage being plastic. The deformation of mating thread 42, occurs primarily along the flanks 48 in the vicinity of the minor diameter 44 and, as best seen in Figure 4, the material forming thread 42 flows inwardly toward shank 14 of bolt 10 from a point inwardly of an imaginary cylinder through the flanks 48 at a radial point intermediate the crests and roots of the thread 42 and indicated by line X—X in Figures 3 and 4 causing the minor diameter to become smaller both in the diameter and an axial thickness. In Figure 4, the original configuration of thread 42 is illustrated in solid lines and the configuration after engagement with locking portions 26 is illustrated in dotted lines. It should be noted that little or no deformation of thread 42 occurs along flanks 48 in the region extending from the imaginary cylinder indicated by line X X to major diameter 46. Since the mating thread is not substantially deformed in the region where it is engaged by the thread of the fastener, the re-usability of the mating thread is improved.

While the exact reason why little or no deformation of mating thread 42 occurs in the region between the imaginary cylinder indicated by line XX and major diameter 46 is not fully understood, it is believed that since flank portions 22A and 24A engage both flanks 48 of the mating thread in that region, movement of material forming the mating thread in that region is resisted by flank portions 22A and 24A. However, little or no contact between flank portions 22A and 24A occurs inwardly of the imaginary cylinder indicated by line XX so that the material forming thread 42 can flow inwardly thus reducing minor diameter 44 in both diameter and thickness.

In addition, it has been observed that as locking portions 26 engage mating thread 42, there is a tendency to pull the nut off axis so that at a point spaced 180 degrees from the locking portions, there is a tighter engagement between thread 16 and thread 42 which adds to the locking characteristic of the assembly. It is for this reason that it is preferred to keep the circumferential extent of locking portions 26 less than 180 degrees. Of course, if the additional locking is desired, locking portions 26 should be axially aligned on adjacent thread convolutions. At this point it will be noted that screw 10 can be economically manufactured by generally conventional techniques. The difference in manufacturing techniques resides in the thread-rolling operation which would involve the use of a thread rolling die having a plurality of displaced rib portions complementary to locking portions 26 formed adjacent one end. The screw blank is rolled between a pair of dies as is conventional to first form helical thread 16 on the shank portion of the blank. As the blank continues to rotate between the dies it engages with the displaced rib portions to

displace thread 16 and form locking portions 26. When thread 16 is displaced some of the material adjacent root 18 flows to form root portion 18A and a small amount flows toward head 12 into overlapping relationship with the normally non-load flank of the thread to form bubble 28. This bubble is not always formed but is present in most instances.

While in the foregoing there has been disclosed a preferred embodiment of the invention, it should be understood that various modifications may be made thereto without departing from the scope of the invention as recited in the appended claims.

WHAT WE CLAIM IS:—

1. A fastener of the prevailing torque type comprising a shank having a helical thread formed thereon said thread on the shank including a portion having a load-bearing flank and a non-load-bearing flank, referring to the tightened condition, said flanks being joined at their major diameter by a crest and at their minor diameter by a root, said crest and said root each defining a helix around said shank, at least one segment of said thread on the shank being formed as a locking portion wherein said entire root is axially displaced in one direction relative to the helix of the root of the remainder of the thread, the entire crest adjacent said displaced root is axially displaced in the same direction relative to the helix of the crest of the remainder of the thread and is axially thicker than said remainder of the crest and the surface of said locking portion between said displaced root and said displaced crest is also displaced axially in the same direction as said displaced root and crest.

2. A fastener as claimed in Claim 1 in which the surface of said locking portion between said displaced root and said displaced crest includes a first surface flank portion adjacent said displaced crest for engaging said mating thread and a second surface flank portion relieved from said first surface flank portion intermediate said displaced root and said first surface flank portion.

3. A fastener as claimed in Claim 1 in which the non-load-bearing flank of the locking portion between said displaced root and said displaced crest includes a first surface flank portion extending at an angle from said displaced crest, the included angle between said load-bearing flank and said first surface flank portion being greater than the angle between said load-bearing flank and said non-load-bearing flanks joining said root and crest helices in the remainder of the thread configuration where the root, crest and non-load-bearing flanks are not axially displaced, and a second surface flank portion extending inwardly from said first surface flank portion toward the axis of said fastener.

4. A fastener as claimed in Claim 3 in which the non-load-bearing flanks also includes a third surface extending from said second surface toward the root of the adjacent load-bearing flank.

5. A fastener as claimed in any preceding claim including a plurality of said locking portions.

6. A fastener as claimed in Claim 5 wherein said locking portions are adjacent each other on the same convolution of the thread, the convolution extending through a segment of 360° around the thread.

7. A fastener as claimed in Claim 5 wherein said locking portions are on adjacent convolutions of the thread, each convolution extending through a segment of 360° around the thread.

8. A fastener as claimed in any preceding claim wherein the or each said locking portion has a circumferential extent of less than 180°.

9. A fastener as claimed in Claim 6 wherein said locking portions have a total circumferential extent less than 180°.

10. A joint assembly comprising a plurality of workpieces each having an opening extending therethrough, a fastener in accordance with any preceding claim in which the thread on the shank portion thereof is externally-formed on the said shank portion, and an internal thread configuration having a mating thread generally complementary to said external thread on the fastener.

11. A joint assembly in accordance with Claim 10 wherein said mating thread is formed in one of said workpieces.

12. A joint assembly in accordance with Claim 10, wherein said mating thread is formed in a nut member.

13. A fastener of the prevailing torque type constructed and arranged substantiially as described herein with reference to the accompanying drawings.

14. A joint assembly constructed and arranged substantially as described herein with reference to the accompanying drawings, and particularly as shown in Figure 2 thereof.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1

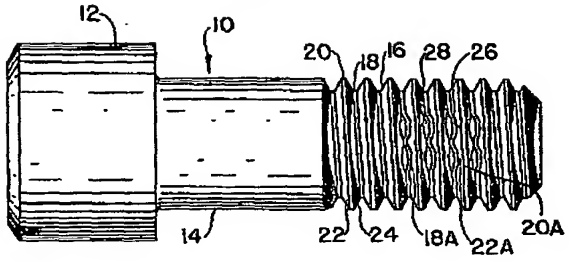

FIG. 2

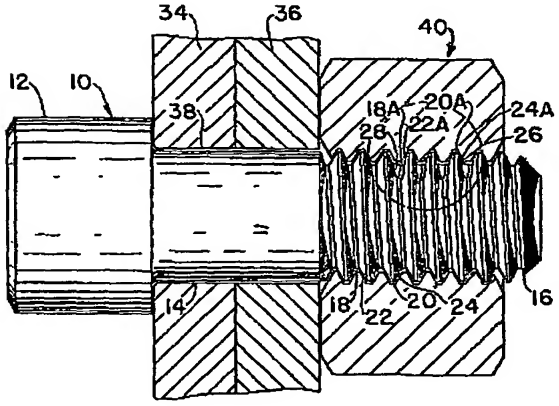

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FIG. 3

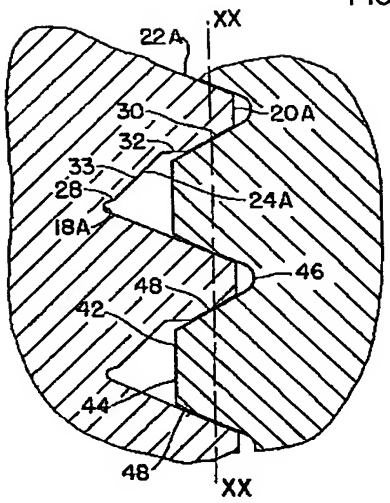

FIG. 4